Department of Pesticide Regulation

Mary-Ann Warmerdam
Director

Arnold Schwarzenegger
Governor

April 5, 2005

TO: Interested Parties

SUBJECT: 2005 UPDATE OF VOLATILE ORGANIC COMPOUND EMISSION INVENTORY

The Department of Pesticide Regulation (DPR) has completed the annual volatile organic compound (VOC) emission inventory based on the 2003 pesticide use data for five nonattainment areas. DPR prepared the inventory as part of its commitment to reduce pesticide VOC emissions under the 1994 State Implementation Plan for Agricultural and Commercial Structural Pesticides.

As expected, the 2003 pesticide VOC emission inventory mirrors the 2003 pesticide report that showed a slight decrease for one area and slight increases for the other areas compared to 2002. For the Sacramento Metropolitan and South Coast nonattainment areas, the 2003 pesticide VOC emission inventory continues to meet commitments made in the 1994 State Implementation Plan. The pesticide VOC emission inventory for the Ventura and Southeast Desert nonattainment areas does not meet the target goals. However, we have until 2005 and 2007, respectively to meet the commitment for these nonattainment areas.

For the San Joaquin Valley nonattainment area, we committed to reduce pesticide VOC emissions by 12 percent for 1999 and beyond. For several years, the pesticide VOC emission inventory trend for the San Joaquin Valley showed considerable and steady progress toward meeting the 12 percent reduction goal, and was met in 2001. However, pesticide VOC emissions have increased for the last two years in the San Joaquin Valley, and in 2003 emissions were approximately 26 percent above the 1999 reduction goal.

DPR and the Air Resources Board have initiated several efforts to improve the accuracy of the emission estimates and achieve the reduction goals. Earlier this year, the Air Resources Board approved funding for two pesticide research projects. One project will determine the reactivity (ability to create ozone) for several pesticides. The second project will investigate methods to reduce emissions from fumigant pesticides. Fumigants account for approximately 50 percent of the pesticide VOC emission inventory in the San Joaquin Valley area and 80 percent or more for the Southeast Desert and Ventura nonattainment areas. Reducing fumigant emissions will be a key factor in reducing VOC emissions from pesticides.

In February 2005, we initiated a reevaluation to request emission potential data for approximately 800 pesticide products. This data is due by the end of 2005 and will enable us to more accurately estimate VOC emissions from pesticides. DPR will soon require the same data for new pesticide products. We will continue to work with others to identify and implement additional measures to improve the accuracy of VOC emission estimates and reduce VOC emissions from pesticides.

If you have questions, please feel free to contact me.

Sincerely,

Paul H. Gosselin
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bcc: Segawa Surname File

Department of Pesticide Regulation

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M E M O R A N D U M

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TO: John S. Sanders, Ph.D., Chief
Environmental Monitoring Branch

FROM: Lin Ying Li, Ph.D., Associate Environmental Research Scientist
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DATE: April 5, 2005

SUBJECT: JANUARY 2005 UPDATE TO THE PESTICIDE VOLATILE ORGANIC COMPOUND INVENTORY: ESTIMATED EMISSIONS 1990–2003

OVERVIEW

This memorandum summarizes the Department of Pesticide Regulation's (DPR's) January 2005 update of estimated pesticide volatile organic compound (VOC) emission data, with particular attention to May-October "ozone season" emissions in California's five nonattainment areas (NAA). Electronic files containing detailed statewide 1990–2003 data are available by download from DPR's Web site at <http://www.cdpr.ca.gov/docs/pur/vocproj/vocmenu.htm> along with a variety of VOC documentation.

The calculation procedures used in this revision of the 1990–2003 annual VOC inventories included three major revisions to the previous procedure. These were (1) modifying default emission potentials for all methyl isothiocyanate–generating fumigant products containing metam-potassium (potassium N-methyl dithiocarbamate), (2) including additional agricultural-use products that had previously been excluded from the inventory, and (3) modifying procedures used to determine probable outliers in the pesticide use data that is used to calculate inventory. These changes were implemented to improve the consistency and accuracy of DPR's VOC inventory. The net result was an increase in total estimated 1990–2002 statewide pesticide emissions of 1.01 percent. However, the increases in certain NAAs were either larger or smaller than the statewide average. The largest change was in the Southeast Desert (NAA 3), where the average increase across all years was 2.74 percent, followed by Sacramento Metropolitan Area (NAA 1) with a 2.60 percent increase, San Joaquin Valley (NAA 2) with 1.48 percent increase, in the South Coast (NAA 5) with a 0.96 percent increase, and in Ventura (NAA 4) with a 0.06 percent increase. A detailed explanation of the calculation changes will be posted to DPR's VOC Web site (Spurlock, 2005).

The 2003 VOC emissions are based on DPR's preliminary 2003 pesticide use data, released in January, 2005 (DPR, 2005). Except for the modifications summarized above, the VOC calculation procedures were essentially the same as those employed in previous inventories. NAAs are defined according to the U.S. Environmental Protection Agency's most recent 1-hour

ozone standard NAA boundaries <http://www.epa.gov/region9/air/maps/r9_o3.html>. The NAA attainment goals discussed are those listed in the January 8, 1997 Federal Register (Federal Register, 1997). The attainment goals are based on the 1990 pesticide emissions inventory, which vary in both emission rate and year among nonattainment areas (Table 1). The goal emission rate was set at 80 percent emission level of 1990 for all nonattainment areas except NAA2, which was set at 88 percent of 1990 emission level.

Table 1: 1990 May–October (Ozone season) pesticide VOC emissions in NAAs 1–5, and emission goals for each NAA.

		VOC Emission Goal	
NAA	1990 VOC Emission (US-tons/day)	Goal Rate (US-tons/day)	Goal Year
1-Sacramento Metropolitan	2.974	2.379	2005
2-San Joaquin Valley	23.988	21.109	1999
3-Southeast Desert	1.257	1.005	2007
4-Ventura	4.525	3.620	2005
5-South Coast	11.021	8.816	2010

Compared to year 2002, VOC emissions from pesticide applications in 2003 increased in all nonattainment areas except in Sacramento Metropolitan Area (NAA1) (Figure 1). San Joaquin Valley (NAA2) showed a second year continuous increase in VOC emission since 2001. In Southeast Desert (NAA3) and Ventura (NAA4), pesticide VOC emissions reached its historical highest since 1990. The 2003 VOC emissions in NAA1 and South Coast (NAA5) were both below their emission goals. Other nonattainment areas (NAA2–4) that did not meet their emission goals in 2002 showed increased VOC emissions in 2003.

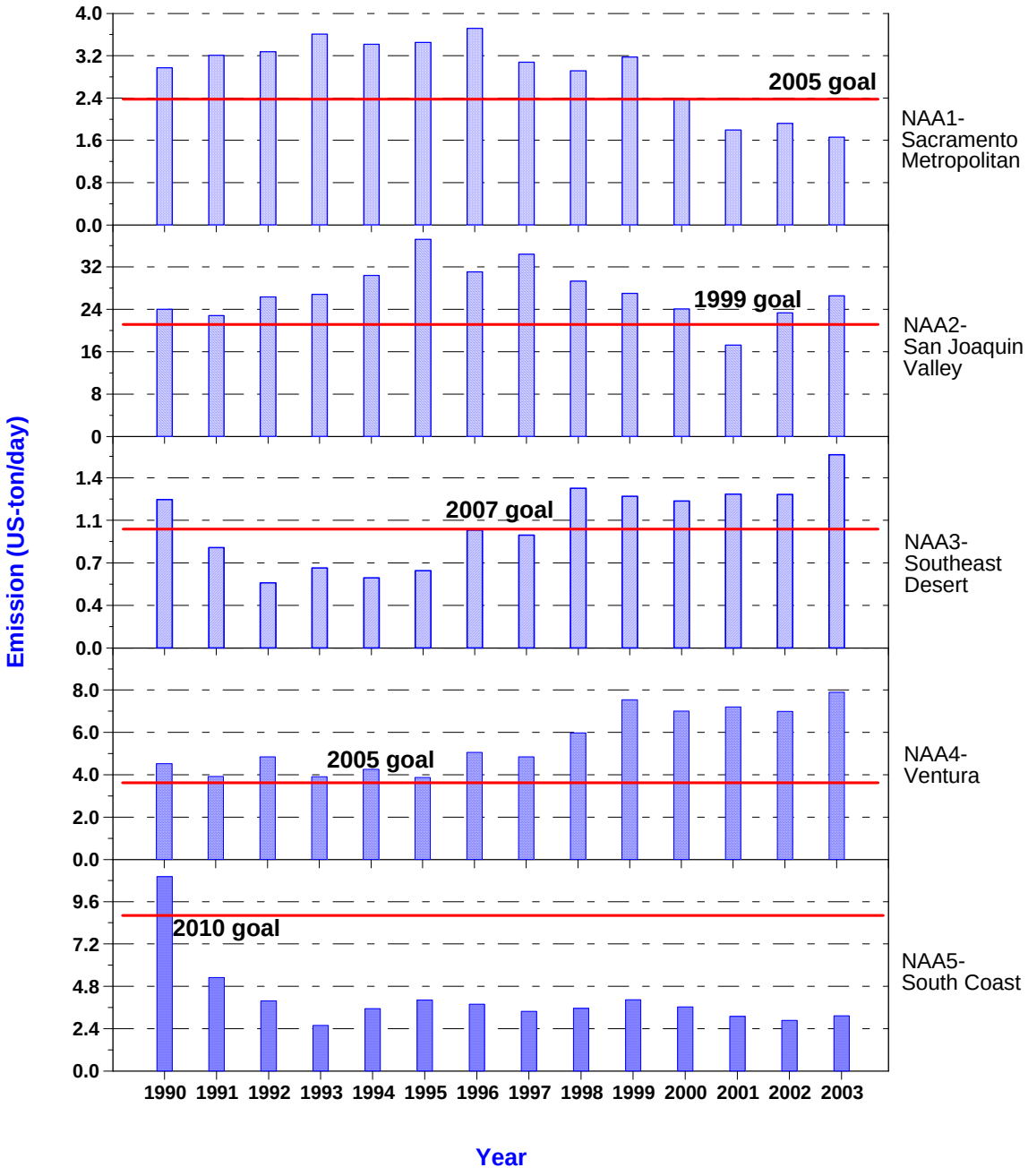

Figure 1 1990–2003 May–October (Ozone season) pesticide VOC emissions in nonattainment areas 1–5.

VOC INVENTORY RESULTS BY NONATTAINMENT AREA

A VOC emission inventory database has been established for storing, querying, and analyzing VOC emission data from pesticide applications (Li and Spurlock, 2005). In the following sections, VOC emissions in each nonattainment area are grouped by chemical source, application site, and emission category defined by the Air Resources Board. The top-ten primary active ingredients and the top-ten application sites contributing to VOC emissions are listed for each nonattainment area. The percentages of their contributions to the total ozone season emissions are calculated. The primary active ingredient is defined as the pesticidal active ingredient presented at the highest percentage in a product. If a pesticide product contains 20 percent of active ingredient 'A' and 10 percent of active ingredient 'B', all estimated emissions from that product are assigned to the primary active ingredient 'A'. This approach prevents "double-counting" of emissions from products containing two active ingredients. The Air Resources Board defined the VOC emission inventory from pesticide applications in four categories: methyl bromide emissions from agricultural applications, non-methyl bromide emissions from agricultural applications, methyl bromide emissions from structural applications, and non-methyl bromide emissions from structural applications. The VOC emission inventory of 2003 from each category is calculated for NAA1–5. VOC emissions are only estimated for the ozone season, which was defined as a period from May to October. The VOC emission level is evaluated by US-ton/day of total organic gas, where a US-ton equals 2000 pounds.

A. Sacramento Metropolitan (NAA1)

The 2003 VOC emissions in NAA1 during the ozone season were 1.661 US-ton/day, which was 13.44 percent lower than that of 2002. The VOC emissions in the Sacramento Metropolitan area continued the decreasing trend since 1999, and the 2003 emissions were the lowest since 1990 (Figure 1). Molinate, an herbicide used in rice fields, was the main source of volatile organic compounds in this area, comprising almost a quarter of the total VOC emissions of the area (Table 2). Followed by 1,3-dichloropene, a fumigant for soil sanitation of nuts and tomato, which contributed more than 10 percent of VOC emissions of this area. The main application sites were rice, walnuts, processing tomatoes, fumigation, and wine grapes (Table 3). The VOC emission from methyl bromide was very limited in this area (Table 4), consisting only 5.6 percent of total emission (Table 2). The 2003 VOC emission inventory data of NAA1 reflected the agricultural characteristics of the area.

Table 2: Top ten pesticide active ingredients contributing to 2003 May–October VOC emissions in NAA1.

PRIMARY AI	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA1
MOLINATE	0.390	23.5
1,3-DICHLOROPROPENE	0.167	10.1
CHLORPYRIFOS	0.096	5.8
METHYL BROMIDE	0.092	5.6
THIOBENCARB	0.088	5.3
GLYPHOSATE, ISOPROPYLAMINE SALT	0.085	5.1
TRIFLURALIN	0.072	4.3
CYPERMETHRIN	0.060	3.6
SULFUR*	0.047	2.9
PROPYLENE OXIDE	0.041	2.5

* VOC emissions from sulfur products are due to the inert ingredients in some formulations

Table 3: Top ten pesticide application sites contributing to 2003 May–October VOC emissions in NAA1.

SITE	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA1
RICE	0.535	32.2
WALNUT	0.166	10.0
TOMATO, PROCESSING	0.152	9.1
STRUCTURAL PEST CONTROL	0.138	8.3
SOIL FUMIGATION/PREPLANT	0.096	5.8
GRAPE, WINE	0.081	4.9
COMMODITY FUMIGATION	0.078	4.7
RIGHTS OF WAY	0.059	3.6
LANDSCAPE MAINTENANCE	0.045	2.7
FUMIGATION, OTHER	0.040	2.4

Table 4: 2003 May–October VOC emissions (US-tons/day) by emission inventory classification in NAA1.

MEBR FLAG	AgUse	Non-AgUse	Total
MeBr	0.085	0.000	0.086
Non-MeBr	1.438	0.138	1.576
Grand Total	1.523	0.138	1.661

B. San Joaquin Valley (NAA2)

The 2003 VOC emissions of the San Joaquin Valley Nonattainment Area (NAA2) were 26.52 US-tons/day in NAA2, which was a 13.71 percent increase from 2002. The VOC emissions in NAA2 were on a rising track from 1990 to 1995, and then showed a decreasing tendency from 1995 to 2001. The highest year and lowest year of VOC emissions were 1995 and 2001, respectively. Since 2001, the VOC emissions increased more than 10 percent each year, and the VOC emissions in 2003 were above the 1999 goal.

Fumigants were major contributors to the VOC emissions in NAA2 in 2003 (Table 5). The top four fumigants -metam-sodium, 1,3-dichloropropene, methyl bromide, and potassium N-methyldithio carbamate contributed 51.9 percent of the total VOC emissions of the area. Carrots, cotton, and almonds were the major crops being treated by fumigants (Table 6). VOC from these three crops totaled 42.7 percent of all VOC emissions in the area. Although fumigants were major VOC-producing pesticides of the area, the percentage of VOC emissions from methyl bromide was only 10.8 percent (Tables 5). The widespread use of methyl bromide alternatives, such as metam-sodium and 1,3-dichloropropene, reduced the VOC emissions from methyl bromide.

Table 5: Top ten pesticide active ingredients contributing to 2003 May–October VOC emissions in NAA2.

PRIMARY AI	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA2
METAM-SODIUM	5.808	21.9
1,3-DICHLOROPROPENE	4.097	15.4
METHYL BROMIDE	2.855	10.8
CHLORPYRIFOS	2.307	8.7
GLYPHOSATE, ISOPROPYLAMINE SALT	1.604	6.0
POTASSIUM N-METHYLDITHIO CARBAMATE	1.008	3.8
ACROLEIN	0.561	2.1
DIMETHOATE	0.491	1.9
TRIFLURALIN	0.456	1.7
SULFUR*	0.447	1.7

* VOC emissions from sulfur products are due to the inert ingredients in some formulations

Table 6: Top ten pesticide application sites contributing to 2003 May–October VOC emissions in NAA2.

SITE	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA2
CARROT	4.658	17.6
COTTON	3.514	13.3
ALMOND	3.132	11.8
N-OUTDR PLANTS IN CONTAINERS	1.260	4.8
GRAPE	1.186	4.5
POTATO	1.075	4.1
ORANGE	1.028	3.9
RIGHTS OF WAY	1.014	3.8
SOIL FUMIGATION/PREPLANT	0.879	3.3
BROCCOLI	0.845	3.2

Table 7: 2003 May–October VOC emissions (US-tons/day) by emission inventory classification in NAA2.

MEBR FLAG	AgUse	Non-AgUse	Total
MeBr	2.525	0.016	2.541
Non-MeBr	23.656	0.321	23.977
Grand Total	26.182	0.337	26.519

C. Southeast Desert (NAA3)

The VOC emissions in the Southeast Desert Nonattainment Area reached 1.637 US-tons/day in 2003, which was more than 25 percent higher than that of 2002, and was also the all time highest since 1990. This was about 60 percent higher than the 2007 emission goal. The VOC emission level in NAA3 was generally lower than or close to 1 US-ton/day prior to 1997 with only one exception in 1990. Since 1998, however, the VOC emission level has been consistently higher than 1 US-ton/day, and an apparent leap in 2003.

Soil fumigants played a dominant role in VOC emissions in NAA3, metam-sodium alone contributed nearly half of the total emissions, and another 17.0 percent was attributed by methyl bromide (Table 8). Carrots, peppers, and strawberries were the leading crops being treated with soil fumigants. The combined contribution was 43.1 percent of total VOC emissions (Table 9). The percentage of VOC emission from uncultivated agriculture also reached 11.5 percent. The VOC emissions from methyl bromide were 0.225 US-tons/day (Table 10), which was about 17.0 percent of the total emissions. Compared to metam-sodium (48.6 percent), methyl bromide was the second most used VOC-producing pesticide in the area.

Table 8: Top ten pesticide active ingredients contributing to 2003 May–October VOC emissions in NAA3.

PRIMARY AI	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA3
METAM-SODIUM	0.795	48.6
METHYL BROMIDE	0.279	17.0
POTASSIUM N-METHYLDITHIO CARBAMATE	0.120	7.3
GLYPHOSATE, ISOPROPYLAMINE SALT	0.092	5.6
1,3-DICHLOROPROPENE	0.076	4.7
CHLOROPICRIN	0.034	2.1
CHLORPYRIFOS	0.027	1.7
PERMETHRIN	0.021	1.3
MALATHION	0.019	1.2
EPTC	0.019	1.2

Table 9: Top ten pesticide application sites contributing to 2003 May–October VOC emissions in NAA3.

SITE	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA3
CARROT	0.247	15.1
PEPPER, FRUITING	0.245	15.0
STRAWBERRY	0.213	13.0
UNCULTIVATED AG	0.185	11.3
CANTALOUPE	0.099	6.1
POTATO	0.096	5.9
STRUCTURAL PEST CONTROL	0.081	4.9
N-OUTDR PLANTS IN CONTAINERS	0.076	4.6
RIGHTS OF WAY	0.065	4.0
CELERY	0.051	3.1

Table 10: 2003 May–October VOC emissions (US-tons/day) by emission inventory classification in NAA3.

MEBR FLAG	AgUse	Non-AgUse	Total
MeBr	0.225	0.000	0.225
Non-MeBr	1.328	0.084	1.412
Grand Total	1.552	0.084	1.637

D. Ventura (NAA4)

The VOC emission level in the Ventura Nonattainment Area (NAA4) was significantly lower than that of the San Joaquin Valley Nonattainment Area (NAA2), but was substantially higher than all other nonattainment areas in recent years. The 2003 VOC emissions in NAA4 were also the highest since 1990. The VOC emission of NAA4 reached 7.902 US-tons/day during the ozone season of 2003 (Table 11), a 12.98 percent increase from 2002. Soil fumigants again were the leading pesticides of VOC emissions. Differing from NAA2 and NAA3 where metam-sodium led the emission, methyl bromide remained the number one soil fumigant in NAA4, and contributed as much as 76.5 percent of the overall VOC emission in the area. The second largest contributor was 1,3-dichloropropene, and accounted for 8.5 percent of total emission. Strawberries were the dominant crop in the area, and 83.5 percent of VOC emissions were from strawberry fields (Table 12). Pre-planting soil fumigation of strawberry fields with methyl bromide was the primary agricultural practice resulting in VOC emissions in NAA4.

Table 11: Top ten pesticide active ingredients contributing to 2003 May–October VOC emissions in NAA4.

PRIMARY AI	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA4
METHYL BROMIDE	6.044	76.5
1,3-DICHLOROPROPENE	0.670	8.5
METAM-SODIUM	0.383	4.8
CHLOROPICRIN	0.240	3.0
CHLORPYRIFOS	0.145	1.8
GLYPHOSATE, ISOPROPYLAMINE SALT	0.076	1.0
PETROLEUM OIL, UNCLASSIFIED	0.050	0.6
METALDEHYDE	0.027	0.3
CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	0.022	0.3
OXAMYL	0.020	0.2

Table 12: Top ten pesticide application sites contributing to 2003 May–October VOC emissions in NAA4.

SITE	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA4
STRAWBERRY	6.598	83.5
LEMON	0.299	3.8
TOMATO	0.211	2.7
RASPBERRY	0.140	1.8
N-OUTDR FLOWER	0.124	1.6
PEPPER, FRUITING	0.122	1.5
SOIL FUMIGATION/PREPLANT	0.117	1.5
TURF/SOD	0.037	0.5
AVOCADO	0.036	0.5
STRUCTURAL PEST CONTROL	0.027	0.3

Table 13: 2003 May–October VOC emissions (US-tons/day) by emission inventory classification in NAA4.

MEBR FLAG	AgUse	Non-AgUse	Total
MeBr	3.933	0.000	3.933
Non-MeBr	3.942	0.027	3.969
Grand Total	7.875	0.027	7.902

E. South Coast (NAA5)

The 2003 VOC emissions in the South Cost Nonattainment Area were 3.137 US-ton/day, slightly higher than that of 2002 (2.877 US-ton/day). The VOC emissions of NAA5 were far below the 2010 goal in recent years. Sharing some similarities with NAA4, methyl bromide and strawberries were the dominant pesticide and crop contributing to the VOC emissions in NAA5, consisting of 37.6 percent and 39.9 percent of total emissions in their respective category (Tables 14-15). Chloropicrin was the second largest pesticide VOC-producer, contributing 14.6 percent of total emissions. Unique to NAA5, non-agricultural use of fumigants made up 46.7 percent of the total emissions. The main non-agricultural usage of pesticides in NAA5 included structural pest control (26.4 percent), fumigation (8.8 percent), landscape maintenance (5.8 percent), and rights of way (5.7 percent).

Table 14: Top ten pesticide active ingredients contributing to 2003 May–October VOC emissions in NAA5.

PRIMARY AI	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA5
METHYL BROMIDE	1.178	37.6
CHLOROPICRIN	0.457	14.6
PERMETHRIN	0.342	10.9
GLYPHOSATE, ISOPROPYLAMINE SALT	0.170	5.4
METAM-SODIUM	0.088	2.8
BIFENTHRIN	0.072	2.3
CHLORPYRIFOS	0.069	2.2
1,3-DICHLOROPROPENE	0.065	2.1
CYFLUTHRIN	0.062	2.0
CYPERMETHRIN	0.058	1.8

Table 15: Top ten pesticide application sites contributing to 2003 May–October VOC emissions in NAA5.

SITE	Emission (US-tons/day)	percent of all May-Oct 2003 pesticide VOC emissions in NAA5
STRAWBERRY	1.252	39.9
STRUCTURAL PEST CONTROL	0.827	26.4
FUMIGATION, OTHER	0.276	8.8
LANDSCAPE MAINTENANCE	0.183	5.8
RIGHTS OF WAY	0.180	5.7
N-OUTDR PLANTS IN CONTAINERS	0.139	4.4
PEPPER, FRUITING	0.090	2.9
COMMODITY FUMIGATION	0.041	1.3
SOIL FUMIGATION/PREPLANT	0.030	0.9
WATERMELON	0.017	0.5

Table 16: 2003 May–October VOC emissions (US-tons/day) by emission inventory classification in NAA5.

MEBR FLAG	AgUse	Non-AgUse	Total
MeBr	0.919	0.009	0.928
Non-MeBr	1.381	0.827	2.209
Grand Total	2.300	0.836	3.137

III. SUMMARY

Except the Sacramento Metropolitan Area (NAA1), VOC emissions in all other nonattainment areas (NAA 2–5) increased in 2003 from the previous year. The 2003 VOC emissions in NAA1 were the lowest since 1990. The 2003 emissions in NAA1 and NAA5 were both lower than their emission goals. However, VOC emissions in San Joaquin Valley (NAA2), Southeast Desert (NAA3), and Ventura (NAA3) increased in 2003, and all exceeded their emission goals. The VOC emissions in Southeast Desert Area and Ventura Area reached a historical high in 2003. Fumigants (metam sodium, methyl bromide, and 1,3-dichloropropene) continued to be the major pesticides contributing to VOC emissions in all NAAs except in Sacramento Metropolitan Area (NAA1), where herbicide molinate exceeded fumigants as the leading pesticidal VOC-producer.

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